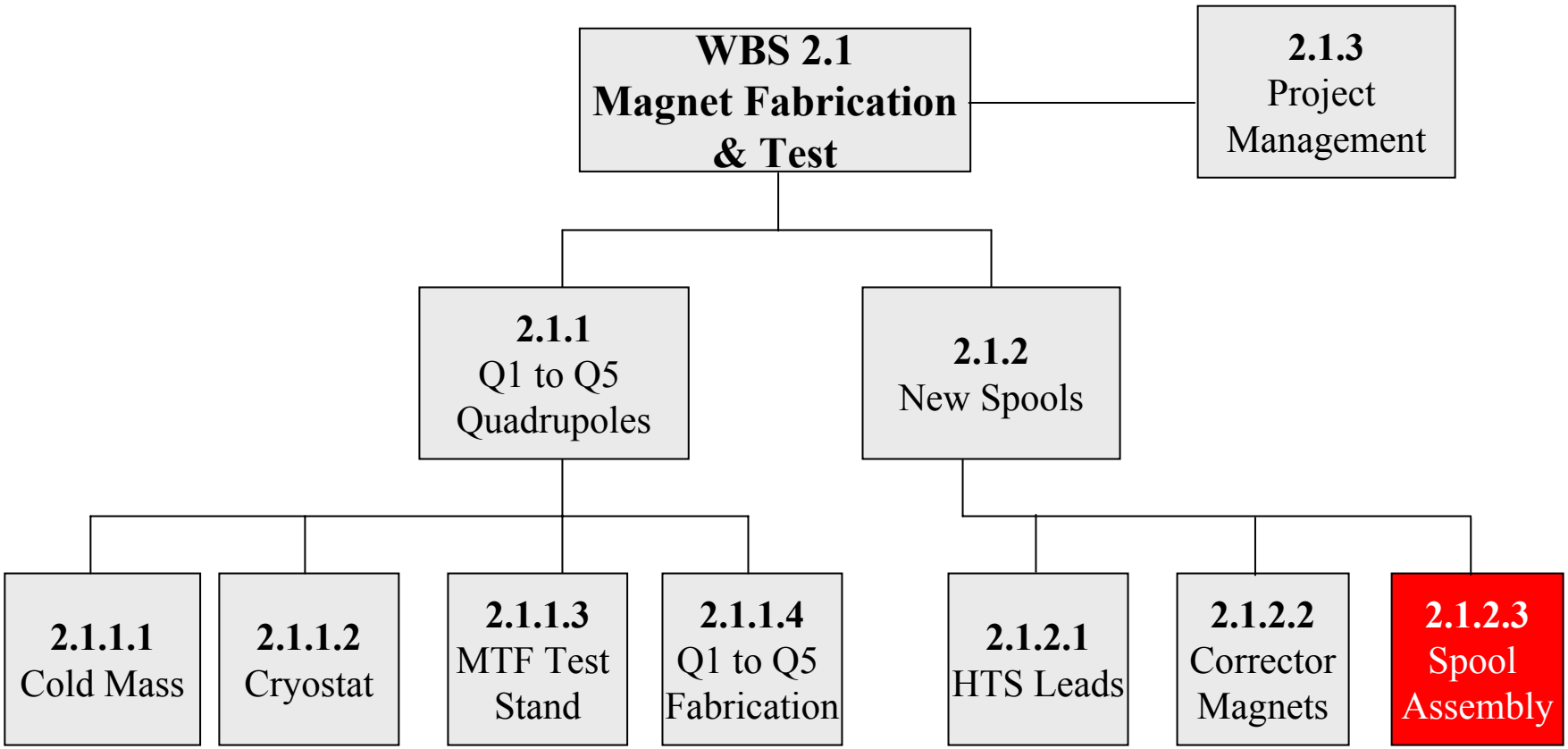
BTeV Spools (WBS 2.1.2.3)

Thomas Page

Topics

- Scope of work
- Spool design parameters
- Spool conceptual design
- Cost and schedule
- Key milestones
- Critical path analysis
- Risk analysis
- Summary

Organization (or "You are here") WBS 2.1.2.3



Scope of Work

- Design and oversee production of two sets of spools plus one spare set.
- Each set consists of 5 spools (X1H, X1V, X2R, X2L, X3) for a total of 15 spools.
- The current plan is to have an outside company fabricate and build the spool assemblies based on our design.
- The major components would be supplied to the vendor.
  - HTS Leads, correctors, other leads, bus work, etc.
- The completed spools will be tested at FNAL.

Initial Design Criteria

- Designed is accordance with ASME Boiler and Pressure Vessel Code
- Design pressure, MAWP*:
  - Single phase: 200 psig
  - Two phase: 50 psig
  - LN_2 system: 100 psig
- Heat load to 4K: 5 W per device (spool, quad, etc.)
- Corrector envelopes:
  - X1 spools: 250 mm OD x 1200 mm long
  - X2 spools: 250 mm OD x 550 mm long
  - X3 spools: 250 mm OD x 800 mm long
- BPM length: 10 inches

* MAWP is Maximum Allowable Working Pressure

Spool Pieces

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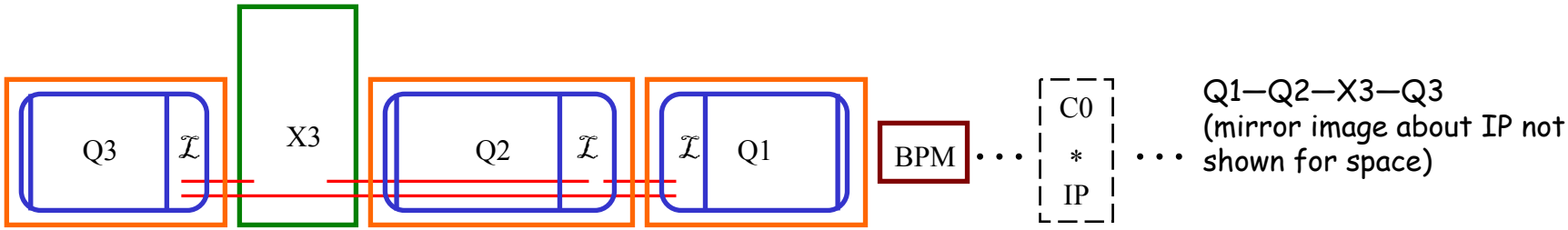
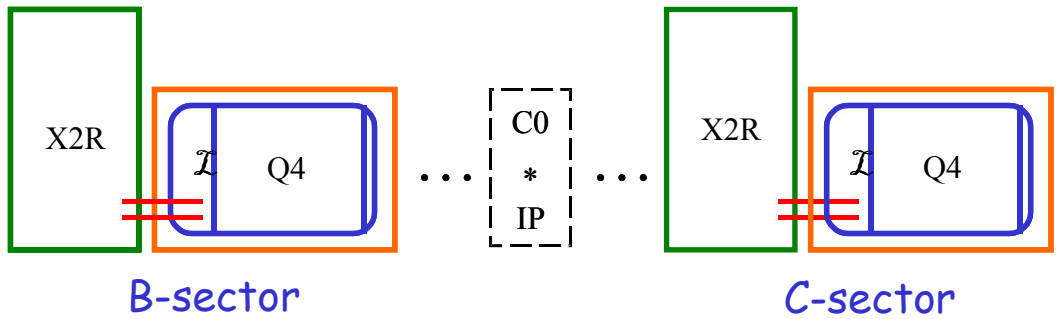
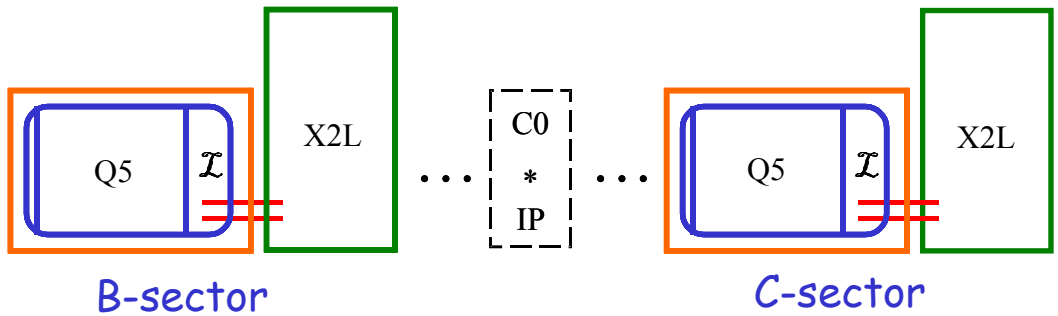


- Spools are located between other components, either new quads or existing Tev equipment (not shown here)
  - X2 variations driven by Q4/Q5 optics
  - X1 (not shown) variations driven by H/V Dipole corrector requirement





Spool Internal Components WBS 2.1.2.3

- Spool component list:
  - Corrector magnets
  - Power leads:
    - 10 kA HTS leads, 4 per power spool (2 pair)
    - Corrector leads
    - 200A leads
  - Instrumentation leads
  - Beam position monitors
  - Relief valves: 3 per spool
  - Cryogenic pipe interfaces as needed
  - Through bus as needed
  - Quench stoppers
  - Vacuum Break

Spool Information

(Details)

Spool	Location	Slot Length, m	VD T. m	HD T. m	SQ T.m/m	Sx T.m/m^2	Q* T.m/m	BPM	HTS Leads	Other Leads
X1V	packb43	1.83	0.48			450	25			3x50A+SL
X1H	packb44	1.83		0.48		450	25			3x50A
X2L	packb47	1.43	0.48	0.48				V&H	2x10kA	2x50A+SL
X2R	packb48	1.43	0.48	0.48				V&H	2x10kA	2 x50A
X3	packc0u	1.43	0.48	0.48	7.5			V&H	2x10kA	3x50A+200A
X3	packc0d	1.43	0.48	0.48	7.5			V&H	2x10kA	3x50A+200A
X2R	packc12	1.43	0.48	0.48				V&H	2x10kA	2x50A
X2L	packc13	1.43	0.48	0.48				V&H	2x10kA	2x50A+SL
X1V	packc16	1.83	0.48			450	25			3x50A
X1H	packc17	1.83		0.48		450	25			3 x 50A+ SL

(Interfaces)

Location	*Designation*	*US comp.*	*US interface*	*US bus*	*DS comp.*	*DS interface*	*DS bus*
packb43	X1V	Quad	Tev	Tev	Dipole	Tev	Tev
packb44	X1H	Quad	Tev	Tev	Dipole	Tev	Tev
packb47	X2L	Q5	modified Tev	Tev, LHC	Dipole	Tev	Tev
packb48	X2R	Cold bypass	Tev	Tev	Q4	modified Tev	Tev, LHC
packc0u	X3	Q3	New	LHC	Q2	New	LHC
packc0d	X3	Q2	New	LHC	Q3	New	LHC
packc12	X2R	Dipole	Tev	Tev	Q4	modified Tev	Tev, LHC
packc13	X2L	Q5	modified Tev	Tev, LHC	Dipole	Tev	Tev
packc16	X1V	Quad	Tev	Tev	Dipole	Tev	Tev
packc17	X1H	Quad	Tev	Tev	Dipole	Tev	Tev

X2 Spool Conceptual Design

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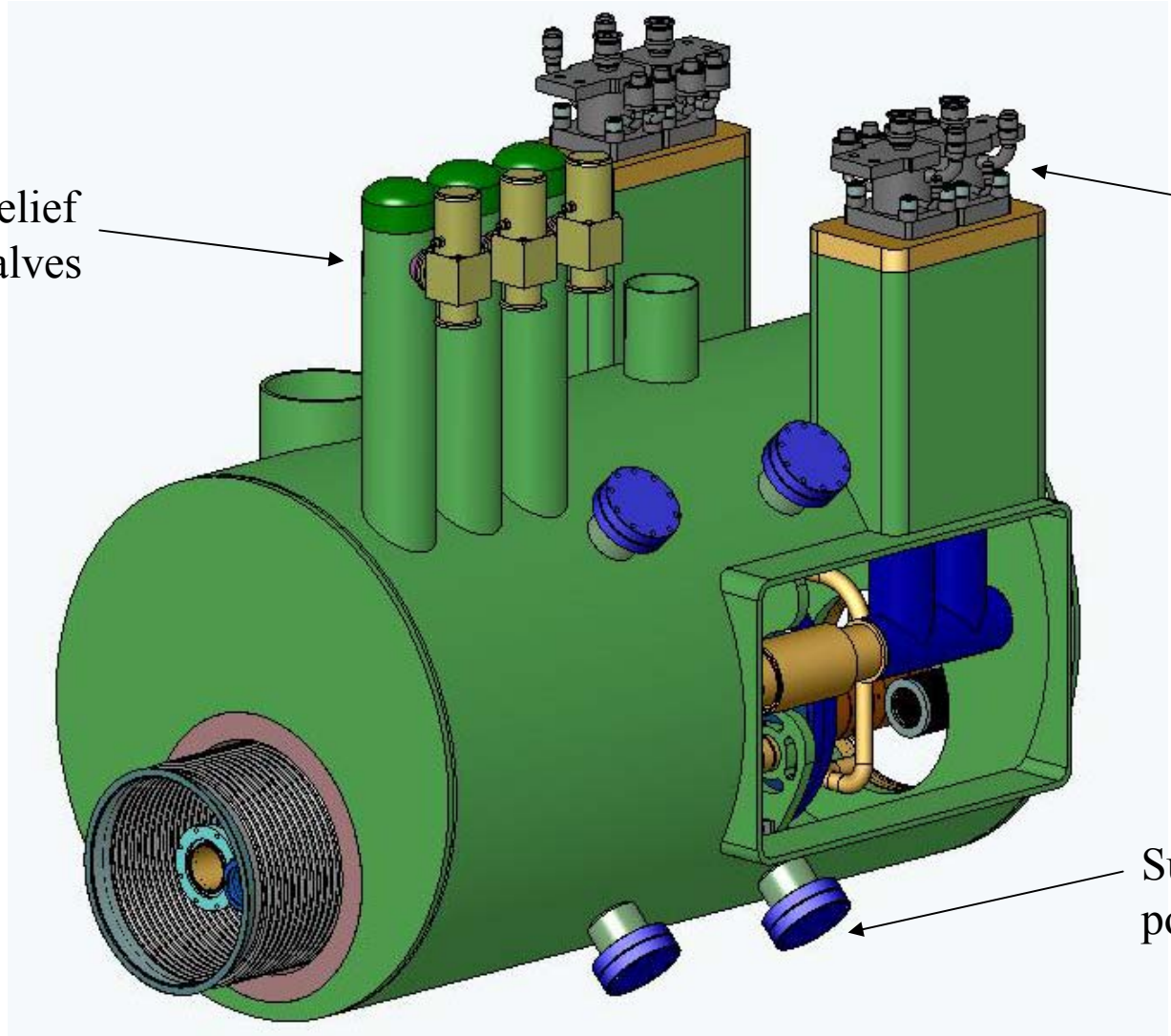
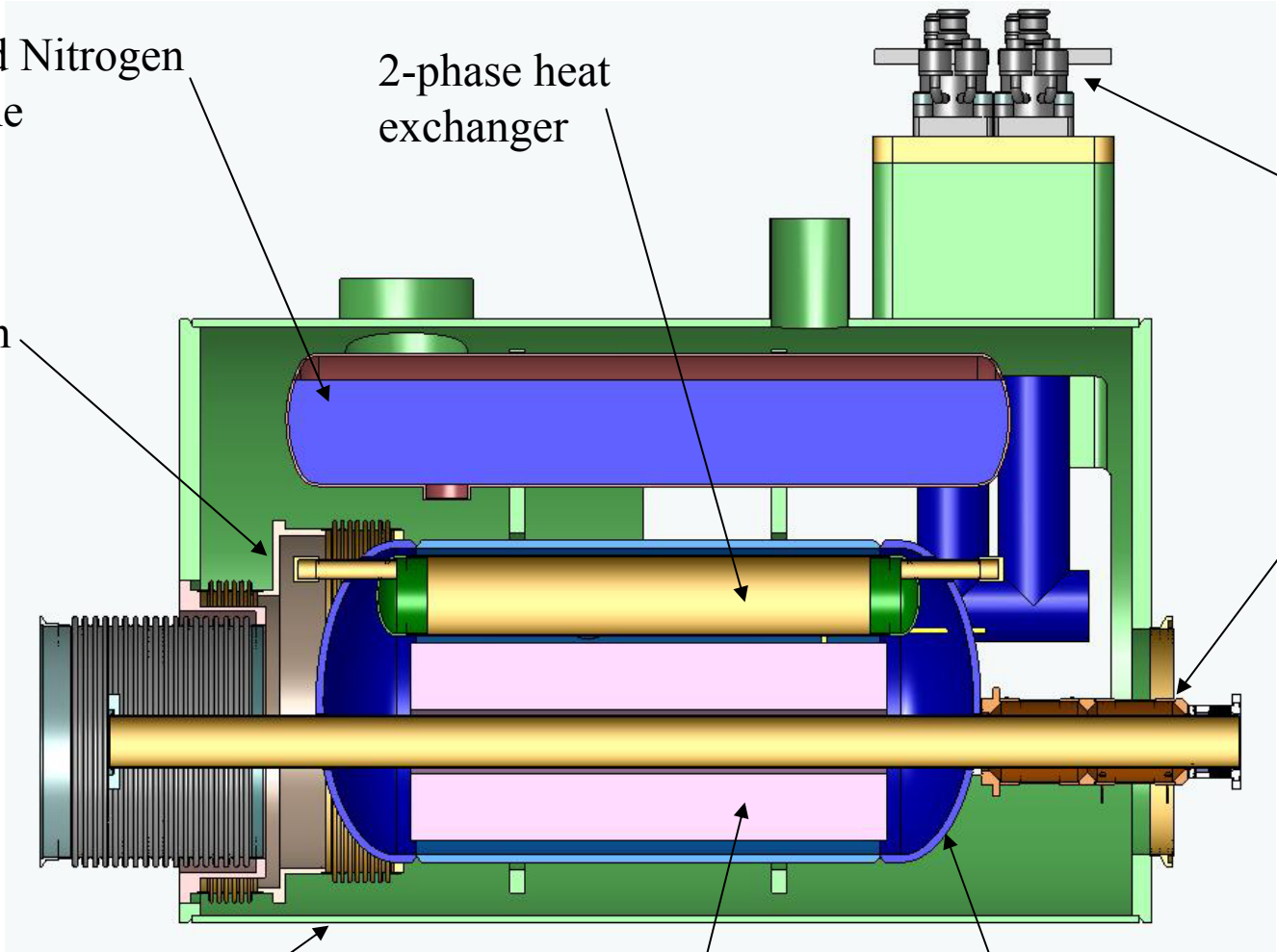


X2 Spool Cross Section



Spool Cost and Schedule Summary WBS 2.1.2.3

- Engineering and design manpower:
  - Engineers: 1.5 FTEs (FY05 & FY06)
  - Designer/drafters: 2 FTEs (FY05 & FY06)
  - 1.5 years of detailed design: October 2005 – March 2006
- Bidding, fabrication, prototype and assembly:
  - March 2006 – May 2009
  - Production oversight: 1 FTE
- Assumes all decisions regarding the internal components are made by October 2004 (start of FY05). This includes:
  - Correctors, HTS leads, instrumentation, BPM's, etc.

Summary of spool cost:

Base cost: $4.959M (Material: $3.276M, Labor: $1.683M)

(Does not include spares.)

Spool Schedule

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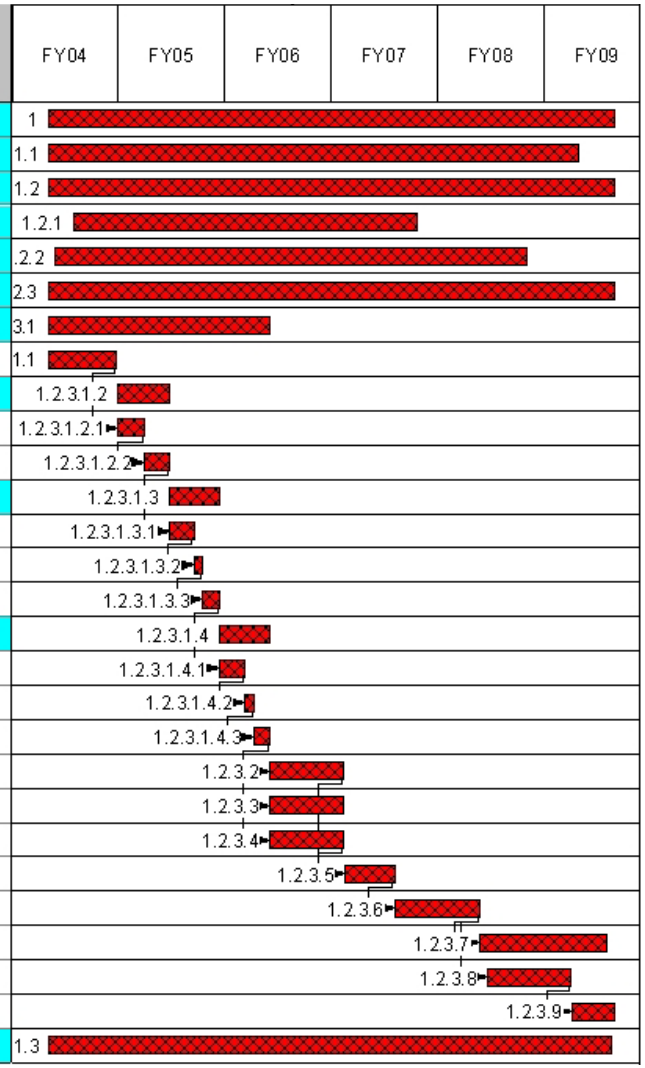
Activity ID	Activity Description	Original Duration	Early Start	Early Finish
1	New magnet fabrication and test	1347d	02Feb04	01Jun09
1.1	LHC-type Quadrupoles	1260d	02Feb04	28Jan09
1.2	New Spools	1347d	02Feb04	01Jun09
1.2.1	HTS LEADS	817d	03May04	24Jul07
1.2.2	CORRECTOR MAGNETS	1122d	01Mar04	05Aug08
1.2.3	SPOOL ASSEMBLY	1347d	02Feb04	01Jun09
1.2.3.1	Spool Design	531d	02Feb04	06Mar06
1.2.3.1.1	Conceptual Design	171d	**02Feb04**	**30Sep04**
1.2.3.1.2	X1 Design	120d	01Oct04	28Mar05
1.2.3.1.2.1	Helium Vessel	60d	**01Oct04**	**29Dec04**
1.2.3.1.2.2	Vacuum Vessel	60d	**30Dec04**	**28Mar05**
1.2.3.1.3	X2 Design	120d	29Mar05	15Sep05
1.2.3.1.3.1	Helium Vessel	60d	**29Mar05**	**21Jun05**
1.2.3.1.3.2	LN2 System	20d	**22Jun05**	**20Jul05**
1.2.3.1.3.3	Vacuum Vessel	40d	**21Jul05**	**15Sep05**
1.2.3.1.4	X3 Design	120d	16Sep05	06Mar06
1.2.3.1.4.1	Helium Vessel	60d	**16Sep05**	**12Dec05**
1.2.3.1.4.2	LN2 System	20d	**13Dec05**	**09Jan06**
1.2.3.1.4.3	Vacuum Vessel	40d	**10Jan06**	**06Mar06**
1.2.3.2	Bidding Process	180d	**07Mar06**	**16Nov06**
1.2.3.3	Bidding Process (with EXEMPT M&S)	180d	**07Mar06**	**16Nov06**
1.2.3.4	Bidding Process for spares (With EXEMPT M&S)	180d	**07Mar06**	**16Nov06**
1.2.3.5	Contract Evaluation	120d	**17Nov06**	**10May07**
1.2.3.6	Prototype Fabrication & Test	200d	**11May07**	**28Feb08**
1.2.3.7	Final Production Oversight	300d	**29Feb08**	**07May09**
1.2.3.8	Spool Cold Tests	200d	**24Mar08**	**08Jan09**
1.2.3.9	Spare Spools Cold Tests	100d	**09Jan09**	**01Jun09**
1.3	Project Management	1341d	02Feb04	21May09



Spool Cost

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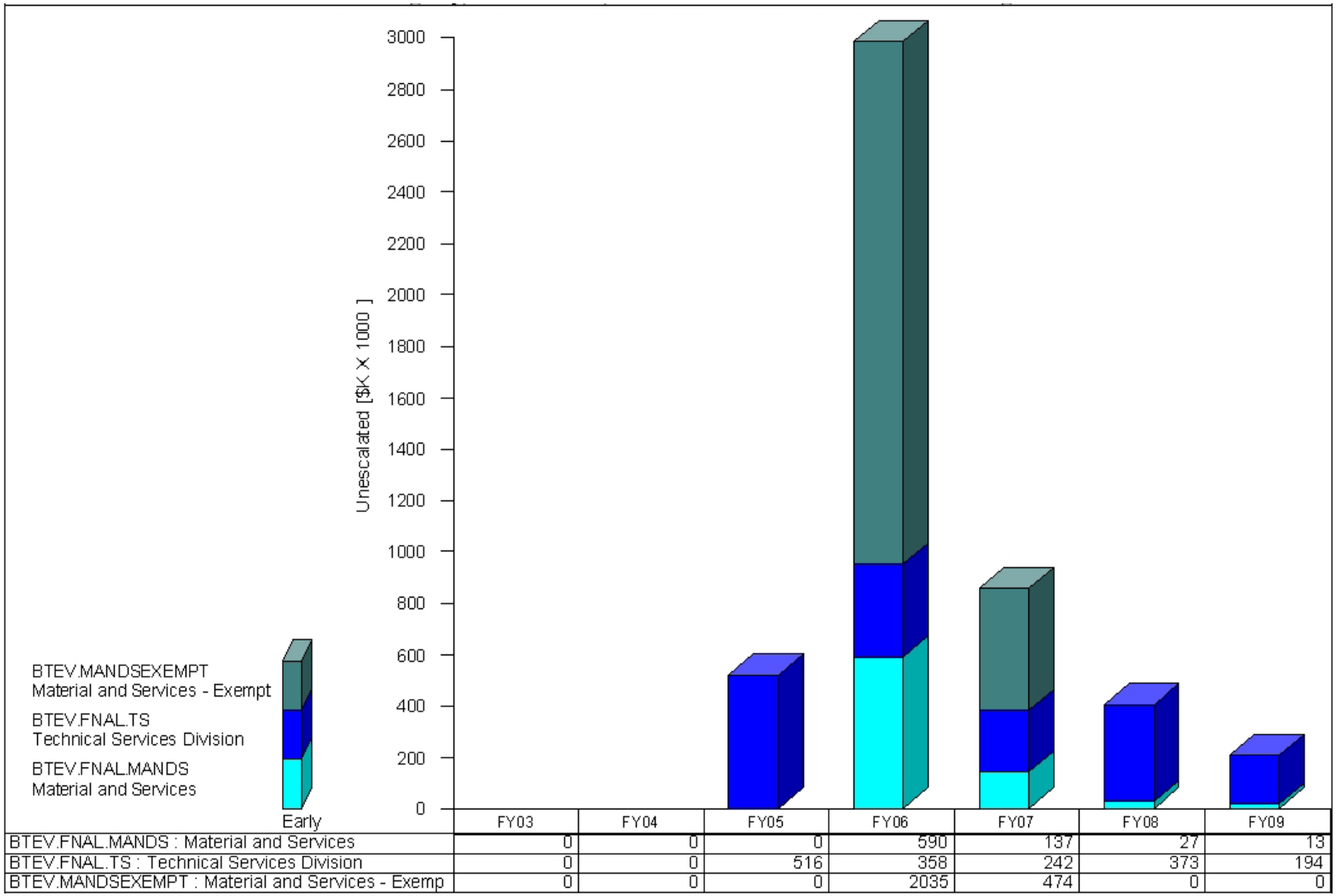

	FY03	FY04	FY05	FY06	FY07	FY08	FY09
BTEV.FNAL.MANDS : Material and Services	0	0	0	590	137	27	13
BTEV.FNAL.TS : Technical Services Division	0	0	516	358	242	373	194
BTEV.MANDSEXEMPT : Material and Services - Exemp	0	0	0	2035	474	0	0

Spool Labor

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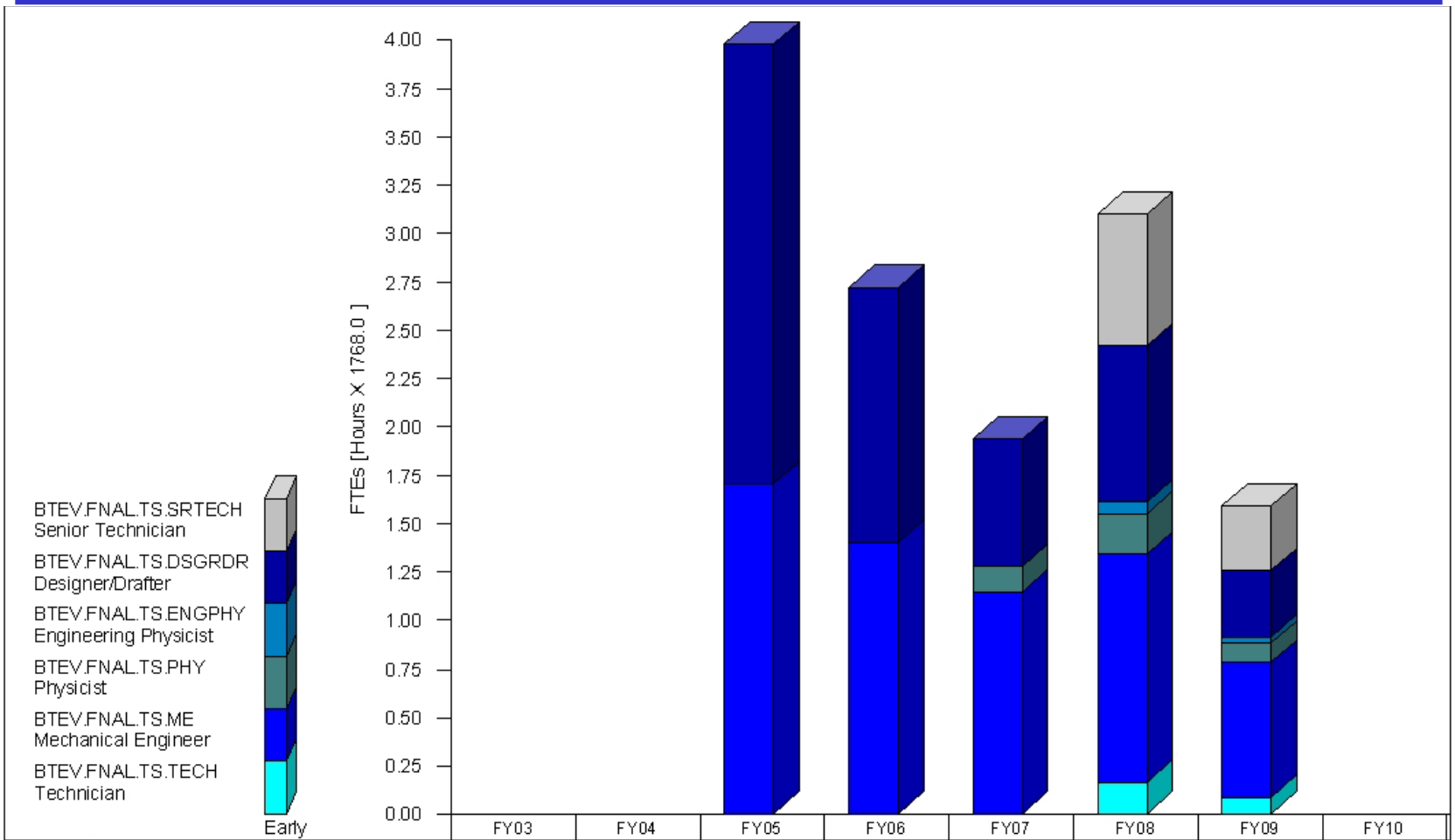

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10
BTEV.FNAL.TS.TECH : Technician	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0
BTEV.FNAL.TS.ME : Mechanical Engineer	0.0	0.0	1.7	1.4	1.1	1.2	0.7	0.0
BTEV.FNAL.TS.PHY : Physicist	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0
BTEV.FNAL.TS.ENGPHY : Engineering Physicist	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
BTEV.FNAL.TS.DSGRDR : Designer/Drafter	0.0	0.0	2.3	1.3	0.7	0.8	0.3	0.0
BTEV.FNAL.TS.SRTECH : Senior Technician	0.0	0.0	0.0	0.0	0.0	0.7	0.3	0.0

Key Milestones

- Start of detailed design – October, 2004 (FY05)
- Bidding process: March, 2006
- Prototype fabrication begins: May, 2007
- Production fabrication begins: February, 2008
- Production and test complete: May, 2009

Critical Path Analysis WBS 2.1.2.3

- Decisions about internal components:
  - The Corrector, BPM and HTS lead decisions need to be made in time so that detailed design can begin.
- Detailed design complete:
  - The detail design needs to be completed in time so that the bidding process may start.
- Vendor production schedule:
  - Timely delivery of components to vendor.
  - Production oversight is critical to keep the vendor on schedule.

Risk Analysis

Risk	***Mitigation***
Manpower not available when needed.	Getting the right people involved early in the design.
Decisions not made in time.	Make this part of the critical path.
Components don't show up in time for delivery to vendor.	We have started the decision making process early and will get the components ordered as soon as possible.
Spool vendor does not complete job in time.	Deal with only qualified vendors. Production oversight.

Summary

- The conceptual design is based on the stated corrector envelopes, BPM length and (4) HTS leads per power spool.
- The remaining components are well understood and the conceptual design is under way.
- Cost estimates for assembly by an outside vendor are based on the LHC DFBX (feedbox) which is similar is size and function to the new spools.
- The cost to design and build the new spools: $4.959M